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THE ROLE OF HIGH SCHOOL TEACHERS IN DISSEMINATING NEW ELEMENTARY SCIENCE CURRICULUMS. FINAL REPORT.

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REPORTED ARE TWO STUDIES OF THE NEWTON, MASSACHUSETTS EDUCATION DEVELOPMENT CENTER. IN ONE STUDY DATA ON WORKSHOPS TO ACQUAINT HIGH SCHOOL PHYSICS TEACHERS WITH NEW SCIENCE CURRICULUM MATERIALS ARE REPORTED. THE WORKSHOPS WERE HELD AT 23 AREA MEETINGS AND ATTENDED BY 755 HIGH SCHOOL SCIENCE TEACHERS DURING THE 1966-67 SCHOOL YEAR. THE WORKSHOPS INVOLVED A TWO-HOUR PRESENTATION AND DISCUSSION ON THE (1) HARVARD PROJECT PHYSICS (HPP), (2) ELEMENTARY SCIENCE STUDY (ESS), (3) INTRODUCTORY PHYSICAL SCIENCE (IPS), AND (4) INTERMEDIATE SCIENCE CURRICULUM STUDY (ISCS). DATA INDICATED (1) THAT HIGH SCHOOL PHYSICS TEACHERS PROFIT FROM EXPOSURE TO NEW SCIENCE CURRICULUM MATERIALS, INCLUDING THOSE DESIGNED FOR THE ELEMENTARY SCHOOL, AND THAT IN SOME CASES, THIS EXPOSURE RESULTS IN THE DEVELOPMENT OF WORKSHOPS FOR OTHER SCIENCE TEACHERS AND THE USE OF THE NEW MATERIALS BY ELEMENTARY AND JUNIOR HIGH SCHOOL TEACHERS, AND (2) THAT THERE ARE MANY SOUND SCIENCE COURSE MATERIALS, BUT THAT THESE NEW MATERIALS ARE NOT WIDELY USED. THE SECOND STUDY INVOLVED HIGH SCHOOL STUDENTS TEACHING ELEMENTARY SCHOOL STUDENTS USING THE NEW SCIENCE CURRICULUM MATERIALS. SPECIFICALLY, 16 HIGH SCHOOL PHYSICS STUDENTS TAUGHT ESS UNITS IN THE ELEMENTARY GRADES, ONE HOUR, THREE DAYS A WEEK OVER A PERIOD OF THREE WEEKS. THE RESULTS DID NOT GIVE CLEAR-CUT ANSWERS TO ANY OF THE QUESTIONS INVESTIGATED. (DS)

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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Education Development Center

Newton, Massachusetts

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Misses Kathleen Manos and Rosemarie Ciccarelli did all of the prelimary work in preparing Part A, Section III, and Miss Manos provided valuable assistance in preparing Part B of this report. Both shared the various responsibilities involved in conducting this study and in typing this report. Their contribution is greatly appreciated.

Ervin H. Hoffart

FORWARD

Activities of two types were investigated in this study. They were:

(a) Workshops for high school physics teachers to acquaint them with new science curriculum materials (reported in Part A), and

(b) Elementary school science workshops for high school students followed by their teaching three to five elementary school students each, using the new science curriculum materials (reported in Part B).

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PART A

Workshops for High School Physics Teachers

I. Introduction

Science teaching in elementary and secondary schools has been undergoing a profound change since 1957. Spurred by advances in technology and a changing world, the demands for more and better science education has produced radical reforms in both content and method. For the first time in the history of American education, groups of university professors, industrial scientists, and elementary and secondary school teachers have devoted their time and knowledge to helping improve the quality of instruction. New textual concepts, motion pictures, specially designed demonstration apparatus -- all the panoply of modern educational skill has been mustered to help meet what has been recognized as a pressing national need.

The high school science teacher has been a key figure in the development, teaching, and refinement of the new science courses. As a pioneer in curriculum reform, the Physical Science Study Committee has leaned heavily on the dedicated high school physics teacher. The success of any program to improve physics instruction in secondary schools depends largely on the men and women in the classrooms. However, many communities have only one physics teacher and opportunities to discuss physics with knowledgeable colleagues are understandably rare. One of the most valuable results of the EDC Area Meeting Program, though it was originally founded for other purposes, has been to alleviate, somewhat, this professional isolation. Many teachers, in fact, have reported that it is the only meeting they attend where physics is the main topic of discussion.

The area meetings were begun in 1958 to solicit the opinions and criticisms of classroom teachers who had used the preliminary course materials developed by the Physical Science Study Committee. Today, however, the area meetings

provide a forum for the exchange of ideas and mutual encouragement among all high school physics teachers within commuting distance of the area meeting center. Equally important, the meetings have helped to establish communication between high school and university physics teachers and have encouraged scholarly accomplishment by high school physics teachers by providing a forum for short papers on topics in physics, teaching techniques, and laboratory apparatus. Lectures on topics in physics by college and industrial physicists, workshops, demonstrations, and screening new films help the teachers keep up with new developments in the field.

The area meeting program recognizes that physics teachers are capable of scholarly accomplishment. The program is sensitive to the needs and wishes of physics teachers; it encourages them to improve their professional competence by engaging their participation in a continuous educational program. To help keep the teaching of physics fresh and dynamic, the meetings encourage the exchange of test questions, new and revised laboratory experiments and apparatus demonstrations, and discussion of the logic, structure, and presentation of the most basic physical concepts.

There are 75 area meeting centers in various parts of the United States. Each center has a chairman or co-chairmen -- an outstanding high school or college physics teacher -- who plans and conducts an average of two meetings a year, in fall and spring. Meetings are customarily held on a weekday evening or Saturday at one of the high schools or colleges in the area.

II. Method

During the 1966-67 school year, workshops were held at 23 area meeting centers attended by 755 science teachers. The workshops included presentations and discussions, usually for about two hours, on the following new science programs: Harvard Project Physics (6), Elementary Science Study (8), Introductory Physical Science (8), and Intermediate Science Curriculum Study (1). The workshop leaders were selected because of their knowledge and experience in developing and

teaching the new materials.

In the early fall of 1967, a questionnaire (Appendix A) was sent to all the teachers who had taken part in the area meeting workshops; 297 or 39 percent of the teachers returned their questionnaire.

III. Results

The following is a compilation of the information received from items 1, 2, and 3 of the questionnaire:

1. Discussed new science curriculum matierals with:

Science coordinator	100
Elementary school teachers	32
Junior high school teachers	89
Others	134

2. Did the discussion result in:

Science workshops for teachers	22
Trying new science curriculum materials by teachers in the system where you are employed	78
Others	84

3. Do you think a discussion of new science curricula is a valuable addition to the area meeting program?

Yes	266
No	2
No Comment	20

Here is a selection of comments from items 3 and 4 of the questionnaires:

"Only by presenting new approaches and methods can science teachers become acquainted with innovations useful and applicable in their own situations."

"I think EDC deserves a big pat on the back for making these meetings possible."

"Anything that results in discussion of the status quo will cause teachers to consider well what they are doing and will help them improve methods and objectives. Outside change agents are usually necessary for change to take place. If well directed will result in improved programs."

"This leads to the development of scope and sequence. It allows the secondary school teacher to observe what is going on at the elem. sch. level. It's surprising how many teachers don't know what is being done at the elem. school level."

"It seems that the leadership for science curriculum reform in the elementary program must come from the Sr. high & Jr. highs. This gives us a chance to see what is being done and to serve as source of information for the Elem. sci. teachers. The program was excellent and provided needed boost to try for curr. changes."

"This is one of the most vital ways that we can keep advised of new and different ways to teach basic material...I hope that this type of program will be continued."

"The more new science curricula being developed and the more discussion of these courses, the better off the state of science teaching is. I believe that new ideas, new methods, new approaches must continually be introduced to the science teacher."

"Keeps us aware of progress, needed change, and in general adds spice to our occupation."

"These area physics meetings should concern themselves with all facets of physics teaching - all new programs should be brought up and studied. If we don't do this, we may end up with such a narrow view of physics teaching that we will have established a new cult or religion -!"

"Most teachers who attend are sincere career professionals, interested in science education all along the front as well as

in physics. Some meetings for this purpose are a good idea, even though they stray from our central purpose."

"One must at least be informed to make intelligent recommendations and decisions."

"I never see or hear enough about the new curricula and even more important what others think of the program. I think the meetings are getting better."

"We secondary school teachers too often depend upon words to put across a simple principle. We have forgotten that simple (to us) demonstrations often can do what words fail to do."

"It led us to a new course at the Academy."

"It gives the secondary teachers, who are usually quite remote of elementary science activities, the opportunity to see & try some of the activities that are designed for the younger set. Also an occasion to evaluate, at least in their own mind & framework, the scope and depth of current Elementary School (science) Units."

"It is difficult to keep up with new developments through periodicals. Exposure to people who are familiar with new methods and materials can do a much better job of keeping one posted on new developments."

"I have found many teachers in the elementary grades are not aware of the new courses in science. The informed, enthusiastic physics teacher can be instrumental in establishing new courses at the lower levels."

"...the area meeting would appear to be a good outlet for informing science teachers of new programs."

"The Area Meetings have been a great help to me and many of my co-workers in the teaching of Physics. The additional spark added by the Project Physics presentation served to broaden concepts and ways of presentation for the teachers present."

"It gives the high school teacher a knowledge of what is happening in the lower grades and the necessity for updating his own teaching if he does not want to bore his students."

"Affords one the chance to hear pilot teachers' reactions and to mess with the equipment. Provides better information than even the most carefully written Newsletter could; provides for interaction, questions & discussion."

"There is really no substitute for hearing about new curricula directly from those people who are involved with it. I feel such contact with these people in our relatively informal meetings is a unique opportunity. Please count my vote for continuation of these EDC sponsored meetings. They are interesting, valuable and unique. Keep it up."

"I have found the spring meeting worthwhile, because it gave me an opportunity to become better acquainted with the IPS program. As a teacher of science on the senior high level I was glad to know what is and can be done in junior high science."

"Any new curriculum deserves consideration. Unfortunately, often the classroom teacher has no way of knowing that this material even exists. I definitely feel that any new ideas are valuable and certainly worthy of discussion at an area meeting."

IV. Discussion, Conclusions, Implications, and Recommendations

The results show that the high school physics teachers profit considerably from exposure to new science curriculum materials, even those designed for use in elementary schools, and, in some cases, this exposure will lead to workshops for other teachers of science in their schools and to the use of the new materials by elementary and junior high school teachers.

The problem in science instruction is no longer one of a shortage of good science materials. There is, in fact, a wealth of pedagogically and scientifically sound science course materials, but these new materials are not widely used today. This study shows that the high school physics teacher (and I

believe this can be expanded to include chemistry and biology teachers) is in a key position to provide a wide range of assistance to elementary and junior high school teachers trying new course materials for the first time.

PART B

Learning By Teaching

I. Introduction

Nearly every teacher has found that teaching is a learning experience for the teacher too. Many teachers learn more about their subject (mathematics, science, English, etc.) the first time they teach it than they do in their college courses. Is there some way that this experience can be made an integral part of education, not only a part of the pre-service education of teachers, but also a part of education beginning in elementary school and continuing through high school, college, and graduate school?

At a symposium held at Cornell University in 1964, Jean Piaget, noted psychologist, said that "Nobody knows better than a professor that the best way to learn something is to teach it."[1]

In 1965, Dr. Jerrold R. Zacharias, Institute Professor of Physics, Massachusetts Institute of Technology, stated, "I want to press for the increased involvement of students with the education of other students—a well-known behavior pattern that I shall call 'learning by teaching'."[2]

In the same talk, Dr. Zacharias said, "...I have been talking about a student learning a subject by teaching a subject, but the student-as-teacher, of course, is also learning how to teach. And he is learning this by the most powerful of all methods, learning by doing."[3]

A pilot program in 'learning by teaching' involving high school physics students was stimulated by Dr. Stefan Machlup, Case Western Reserve University, and conducted during the 1965-66 school year with the help of several physics teachers in the Cleveland, Ohio, area. The results showed that the idea had considerable merit and raised more questions than it answered.[4,5] Some of these questions are the main purposes of this study.

II. Method

How does a teacher plan and conduct a 'learning by teaching' project where students (high school, junior high, or upper elementary) are given the opportunity to teach science to elementary school students? There are various ways to go about it but let me try to explain how it happened in one situation. Mrs. Jean Brattin, physics teacher at Shaker Heights High School, Shaker Heights, Ohio, became interested in trying a 'learning by teaching' project using the ESS unit on "Batteries and Bulbs" after taking part in a workshop at the Cleveland, Ohio, EDC area meeting for physics teachers in November of 1965. (It is, of course, first necessary to get acquainted with the materials developed by one of the new elementary school science projects, such as the Elementary Science Study (ESS), since they make such a venture a practical and attractive possibility. "The aim of the ESS program is to enrich the study of science by bringing its spirit as well as its substance into the classroom...to arouse the curiosity of all children...and to cultivate their desire and capacity for inquiry. It accomplishes this through the use of flexible units, built around phenomena...pupils can observe easily."[6]) Dr. John A. Stanavage, principal at the high school, and Mrs. Marguerite Kummer, principal at the Onaway School, gave their consent to the program; Mrs. Pearl Kuhels, Coordinator of Elementary Science Education, was acquainted with the ESS materials and was eager to cooperate; Mrs. Beth Becka was enthusiastic in trying the experiment with her class of twenty-four third graders.

While acquiring the necessary equipment for the "Batteries and Bulbs" unit, Mrs. Brattin asked for volunteers from her senior physics class to serve as student 'teachers'. "I did a very soft sell, stressing the qualifications needed and the large amount of time they would have to give up both for training and teaching. If a dozen had indicated an interest, I would have been surprised and pleased. I got 43 - all anxiously pestering me to be chosen!"[7] Mrs. Brattin and her colleague, Mr. Wayne French, also a physics teacher, selected six students most likely to succeed. The students had their own 'discovery' session with the "Batteries and Bulbs" unit with help from their two teachers. Shortly thereafter, they became teachers of science for one hour, three mornings a week, for a period of

three weeks. Each student 'teacher' worked with a group of four third-grade children. After getting acquainted, the student 'teachers' passed out a battery, a bulb, and copper wire to each student and the program was underway. After each meeting, the student 'teachers' met to discuss their experiences and to plan the next lesson with guidance from Mrs. Brattin and Mr. French.

Later on, during the same school year, eight student 'teachers' taught a class of fifth-grade students at the Moreland School using materials from the ESS unit on "Microgardening". The mechanism was essentially the same as that used for the previous project.

The project continued on a larger scale for the 1966-67 school year. There were over 90 volunteers who wanted to teach in the elementary schools; only this time everyone who volunteered was allowed to teach. All of the principals and teachers from the elementary schools wanted student 'teachers' and there were more requests than could be filled.

Sixteen teams of high school physics students were distributed among the elementary schools, and each taught for one hour, three days a week, over a period of three weeks. Each student 'teacher' worked with four students. Materials from the ESS units on "Batteries and Bulbs", "Kitchen Physics", "Pendulums", and "Ice Cubes" were used.

The transportation problem was solved by members of the Shaker Heights Parent Teachers Association who handled all the arrangements and provided cars and drivers for the high school students.

Briefly, the ingredients of a successful 'learning by teaching' project are leadership and cooperation. The essential activities are the following: (a) Brief the student 'teachers' on the elementary science unit; (b) Enlist the cooperation of the science supervisor, school principals, and elementary school teachers; (c) Select student 'teachers' on their willingness and desire to participate; (d) Provide materials in sufficient quantity; (e) Schedule regular post-sessions for the student 'teachers'; (f) Plan to evaluate the program in a meaningful way; (g) Assign not more than five students to each student

'teacher'.

III. Results

This study was intended to provide information on the following questions: (1) Do the student 'teachers' learn science in the process; (2) Do the student 'teachers' consider teaching as a career as a result of the experience; (3) Do the elementary school students learn some science and perhaps become more enthusiastic in their studies as a result; (4) Do the elementary school teachers involved take an active interest in the subject matter and method of presentation and want to teach the unit or related units?

The results do not give clear cut answers to any of these questions but they are certainly encouraging. Approximately 300 students, ranging in age from twelve to eighteen, from the very best in ability to the culturally deprived, and from the college-bound to the predicted dropout, participated as student 'teachers'. In nearly all these many cases, the comments from principals, teachers, student 'teachers', and elementary school students are alarmingly favorable. The main criticisms from teachers are the demands on their time and the time of their students.

You may want to study the comments that follow and make your own conclusions. The comments were selected because they were representative and are grouped according to the following categories: (a) student 'teachers'; (b) elementary school students; (c) elementary school teachers; (d) high school teachers and administrators.

COMMENTS BY STUDENT 'TEACHERS':

"What the children discovered on their own not only was easier for them to understand, but was to them most convincing."

"I got carried away when I discovered something myself in the process of teaching, I was opening a battery for a group of children to find out why a battery was so essential..."

"But what's important here is that by this method of teaching, I

was learning and teaching at the same time."

"If we said something, they would refuse to believe it. I thought that this attitude was excellent, because if they would not believe something all they were told to do was to try it."

"Individually I feel we as teachers were adequately prepared, yet as a group we lacked 'team strategy'. This advanced preparation should be stressed in future projects."

"As for my personal reactions toward the experiment, I can honestly say that it was one of the highlights of my high school studies. Beside the considerable amount of basic knowledge I acquired, I also achieved a completely changed outlook on teaching and the educational process. Never before this experiment had I realized the great amount of planning and psychology that a teacher must have to teach a class, especially one this young; not to mention the amount of patience needed."

"Teaching really tests the teacher's understanding of a topic. I found myself looking up in a chemistry book to see exactly how a flashlight battery works and was surprised to see all the misconceptions I had."

"I found that toward the end of the project many of the pupils, and not necessarily the brightest ones, had advanced largly into areas we had not covered in our training sessions."

"The total found was 1465. As a result the group now is convinced that the cupful method is more accurate than the weighing method, but less accurate than one by one counting. About myself I don't know. Before this experiment, I would have thought that the weighing process was more accurate. But now?"

" I do not intend to go into teaching as a career, but I have a better appreciation of what goes into it now than I had before."

"To any question which I didn't know I immediately fired back a series of questions attempting to lead them to a logical conclusion. In one of these instances, my group decided that anything containing chlorophyll will not mold, a fact which I did not even think about until I started a discussion on the

different colored items that had molded in the mold garden."

"One thing I recognized when I started this unit was the eagerness and enthusiasm the children had. Maybe this project was just a time-waster to some, but my group of children exhibited to me that the unit was actually a lot of fun as well as a chance to learn something new. Because it was fun they were anxious to do things, and I counted this behavior as a plus factor for my side."

"My greatest pleasure was a student's discovery that counting a field of corn by rows, then counting the number of stalks in each row, and multiplying these numbers together was so much faster than one by one counting."

"The whole program was to let the students work with science on their own--it was here that the program found its greatest success. The fourth graders had probably never had anything such as this before, and for the first time in their lives they were able to grasp 'science' tangibly and tell something about it. Such 'sciencing' gave even the most reserved student an interest and a chance to become involved.
As far as my personal benefit was concerned, I am afraid that here the program failed. One of the aims was 'learning by teaching', but what science was taught me I could have picked up in just a few hours time. If this is to be one of the goals of the teaching program, then the program must either: (1) be taught to older students, or (2) be taught by younger students. From a pure quantitative aspect the program had to be considered as a waste of class time on my part."

"...the interest shown by both the kids and ourselves was unusually high throughout the entire period. At first I thought that the kids were excited only because we were doing something new, but their interest did not lag even up to the very end, and neither did mine, because I enjoyed every minute of it. I think I was more of a companion than a leader, and I think that the kids realized this too. This was because I was closer to their own ages."

"I recommend working in small groups, so that each student may work as independently as possible. Large groups would be

beneficial for introducing new concepts, such as the 'curtain raiser', or exchanging ideas, as in 'what is a pendulum?' and in presenting an experiment."

"However, interest on the part of the students towards the course in general was quite good as can be shown by the following example. One boy, as was revealed by his teacher, was frequently absent from school--at the slightest cause. The day of our second meeting he arrived at school broken out with hives all over his face. When questioned about it he admitted that he felt sick and didn't want to come to school that morning, but he had to come because he could use the pendulum that day."

"I realize that I am not the best science teacher in the world but it is gratifying to know one ten year old girl thinks so."

"I didn't learn any new knowiedge but this course was very rewarding to me anyhow."

"The students showed a great deal of enthusiasm. However, if the course was not fast moving enough, they lost interest easily and quickly."

"And don't underestimate the kids; I could never have built a wet cell."

"Well, I think the thing that really grabbed the kids was that you put this stuff in front of them. It wasn't a book and it wasn't a mimeographed sheet, but it was a battery, some wire, and a bulb. You know, they could grab it and start making things out of it and that was what the main driving force behind the entire program..."

"I had a little boy who knew more than I did."

"Some of them brought in transistors and other various miscellaneous materials that I couldn't identify. A few carried their work home, and one made a flashlight complete with reflector."

"The only trouble was that they were somewhat disturbed when I neglected to give them an outright answer. That was rather new

to them, but they got used to it. After all, the greatest reward came when they discovered something themselves."

"The course is beginning to drag, and my students are feeling it to some degree. Enthusiasm was extremely high at first-almost spontanously-but now it has died somewhat and is approaching drudgery-"

"This prompts me to ask the question: 'Even though these experiments are erroneous in results, are the correct results necessary on this level?' Perhaps the key to this teaching is just to show that relationships occur not to prove what is a power function & what is indirectly proportional."

"...to teach the teachers less before hand and thus allow the teachers to learn more from teaching."

"Sometimes they enjoyed it too much. It was hard to keep them working as a group because each one was trying something different and didn't seem interested in what the others were doing. They never seemed to have as much equipment as they wanted."

"The satisfaction of teaching could not be bought for all the money in the world."

"Lisa, who had previously been quiet, inhibited, and rather passive, became fascinated with the germinating seeds."

"The slow learner understands much better than the others and suddenly seems to be much more enthusiastic. In fact, he helps the others. I was very surprised."

"Although my knowledge of science helped me, I do not feel that this was a necessity for teaching these children."

"...when teaching the kids about batteries and bulbs, the teacher doesn't need to know much about it. It's more fun to learn as they learn."

COMMENTS BY ELEMENTARY SCHOOL STUDENTS:

"I learned how to weigh things better. I also learned how to keep records. I learned how to count small particles."

"I learned why the bulbs light up and what you have to do to make the light to light up and the light is brighter when you have the glass around it because the glass stores the heat."

"Today I learned, if you put 8 battery's together the bulb will blow. I also learned a lot of ways to light a bulb and if you put alot of batterys together, they all have to be faceing the same way if you want the bulb lit."

"I liked the project. It was fun. I learned a lot of new stuff. I wish we could go on to another project like working with rocks and minerals."

"Fun. Its a blast. I like it. I wish we would have it more ofen. I wish we could have it for a longer period. When can we build the wire building?"

"Science is fun to Study. At first I thought Science was hard but when I tried it I changed my mind. The blocks at first were so easy. But when we came to the ropes that took thinking. I learned a lot from the blocks because they helped me to understand. If the girls would only stay with us longer it seems like one minute before the gils Science teacher turns the lights off!
I wish the girls would come for the whole year. And every single day!
I love science!!!"

"I don't normally like science, but it's interesting to do experiments."

"I learned that pendulums swing at the same speed as long as the strings are the same length. I was interested to know that if you wanted to get one pendulum to go a certain number of times faster than another, you would multiply the number of times you wanted the pendulum to go faster than the other pendulum by itself and that number would be the length of one

string in inches. The other string would be one inch. Then you would start them at the same point and one will go faster."

"I didn't like counting salt because it got tiring, I didn't like counting by ones. I learned that it is easier to count by cups. I also learned to multiply bigger numbers and to count in different ways."

"I liked counting all the things in the jars. I also liked weighing all the objects. And I think it was fun!!
I did not like counting the objects one by one. And also I didn't like counting rice. And I also did not like counting cornstalks. I learned how to count by cupful and wieghing, We also learned to count by the power of tens."

"I suggest that they come more days a week. And that they bring more different things to count."

"I also learned that if I counted one row of things across and counted one row of things down and multiply I'd get the number of all things."

"I think everything was just great especially when we had to show our experiment. I had so much fun I wish we could do it again."

"I learned a lot of everyday things I don't think about."

"When a broken bulb is attached to a battery and wire it works! On the outside of a battery it is coated cardboard. When you try to light a light bulb on the side it will not light because it is not aluminum. When you use a maximum of 8 batteries the light bulb will blow out because of so much power of electricity. We have learned many ways to use a light bulb battery and wire. When you take a thick wire with a coating on it it will not work because the wire has a thick coating over the wire. The more the batteries you add to the bulb and wire the light will become brighter and brighter."

"I think this stuff is O.K. But I don't see why we have it. I mean what subject is it really? The kids who teach us are nice ...What ever they're trying to teach, they do it a little <u>slow</u> at

times. I don't get that much out of those blocks. The cards are like an eye test."

COMMENTS BY ELEMENTARY SCHOOL TEACHERS:

"The high school students created a desire for the fifth graders to observe and experiment for answers to their problems. They encouraged and drew out the students to think thru their ideas in each group. The less able students were able to participate more in this type of project. The more capable at the same time gained a great deal. By the end of the project some of the more capable were wanting to propose problems with the battery for the student teachers."

"The sixth graders continue to be interested in experimenting on their own time at school and at home on bulbs, wires, circuits, etc., so I know there was definitely a 'carryover' in this learning experience."

"One of the most exciting things to observe was the fact that many of the more quiet children became accustomed to talking more, and became more outgoing. This was a big delight to me, to their parents, and I'm sure, to them."

"Some problems of the program were:
1. It is difficult to evaluate just what learnings the children gained.
2. A few children couldn't handle this much freedom well--High School students had some difficulty keeping the attention of those when explanations were needed or something new was started."

"At the end of the program, after the seniors stopped coming, the children hated to return their equipment. We continued using it one more week, but after that had to share with other third grades."

"It teaches the girls lab techniques and teaches them to observe and explain. There was one concept this course lacked. It became overly concerned with telling the students nothing and letting them find it out, that I felt after a few of the experiments the girls didn't fully understand them."

"By the end of the course, it was apparent to me that the students were keenly aware of what they were doing in the laboratory; usually they understood the reasons for what they were doing and observing, however, they often lost enthusiasm for the experiment unless it was explained to them."

"The children absolutely loved having Senior High students--they associated closely with them and had a great deal of respect for them."

"Judging from the enthusiastic response of my class, the Science Program, working with pendulums, was successful in arousing and holding the interest of the pupils. Allowing the children to think for themselves and giving them freedom to experiment made learning both meaningful and enjoyable. I liked the idea of keeping the groups small, of emphasizing individual differences, and of challenging the children, yet allowing them to find success on various levels."

"Kitchen Physics, by its very name, is certainly a new and delightful approach to physics. I feel that the basic idea of using things around you to learn science from, helps the younger student to realize that science is part of everyday life and that its phenomena are around him constantly--not just something he can observe in the science room at school."

"Both the girls and I got a lot out of this course. The girls did because they learned about melting ice, and I did because I learned some very interesting ideas about why ice melts faster in one dish over another!"

"The Seniors have the experience of working with the younger children and from this learn to be more explicit, detailed and probing. I realized that while the children were performing the experiments it was necessary to ask them what was happening at various stages and why instead of just answering their questions."

"In observing the sessions I believe the high school student received a great deal of learning even more than the fourth graders. I, too, learned more about my class. The fourth graders thoroughly enjoyed the experience and each one

gathered at least one new concept."

"There was a definite difference between the ability to move forward by the faster group. They responded quickly. They were able to multiply far beyond their skills prior to this exposure. Working with the large numerals was a real challenge. They also learned to work with the powers of ten. They were lively and seemed to enjoy their teacher and work to the fullest. The slowest group was the last to realize counting by ones was not the best method. All but one child in this group worked hard to accomplish the counting. Their leader used a greater variety of aids to create interest."

"The children were unaccustomed to such an undirected situation. It was new and caused uneasiness at times. Although testing was not suggested I feel that an ungraded test or quiz given on individual group basis would have been fun and self-evaluation for each child. Children are so accustomed to tests that an area seems uncomplete without a test or quiz."

"The fourth graders were not accustomed to this new method of learning. They were looking for words of wisdom from the high school students. They were not as responsive as one would want for this unit." /Peas and Particles/

COMMENTS BY HIGH SCHOOL TEACHERS AND ADMINISTRATORS:

"The principal has had nothing but glowing praise the whole time. He stated that of all things the grade students do - most of which doesn't seem very important (outside of regular classes) this seems head and shoulders above all else. He once said that if they could teach their social studies by this method, we would teach the year's work in about two or three weeks."

"I hope you can come out to visit sometime when we are going full blast. It is crazy, man. Even the PTA is in the act, shuttling kids back and forth every hour on the hour."

"Our original purpose for using this program, 'learning by teaching' was that our students would learn more physics and/or mathematics. As you will see when you read the high school student's letters, we fell somewhat short of this goal. I do

believe, however, that more learning took place than the students indicate."

"One of the items that really does impress me is the report that students, having difficulty all thru school seem to succeed with this and some know answers that others in the group don't. Our groups are a little large so if our PSSC 'teachers' don't have something for them to do every second they give our teachers a little trouble.
They are learning about teaching!
Many teachers have mentioned, and I have also noticed, the fine feeling between seniors and 6th graders. Each seem to have a special respect for the other. You can see the concentration of the seniors and the rapt attention of the 6th graders."

"It has been a most rewarding experience, I feel that the Nottingham students and teachers and the Yorktown students benefitted from the program. I was most impressed with the enthusiasm displayed by the student 'teachers' and the fifth and sixth graders. It is a satisfying experience, too, to see students searching for answers or solutions to problems in a different manner. The interest shown by your students was a great motivating factor. One could also see the shared respect of the learner and the teacher."

"I believe that, concurrently with all of the above, we have piqued the interest of the elementary teachers and have allayed some of their fears concerning the teaching of these new science programs such as ESS. They were making noises that sounded like they wanted to try this sort of thing themselves.
Perhaps the most outstanding characteristic of the experiment was enthusiasm. Students and teachers alike maintained this at a high level throughout the entire program. We hope to try the same sort of project again next year in different schools."

"We go over what we should teach that day. Each one of them has a notebook to write down what happens of interest. They are all having a grand time teaching but they all get back late for the next class and the office is giving me trouble because of this."

"As they began their teaching, many questions came up and

they found out that they did not know everything and they wanted to learn more."

"I feel that the project was very successful. The sixth graders proved not only that teaching reinforces learning but they enjoyed working with the third graders."

"The fourth graders are quite enthusiastic about it and have brought a lot of their own equipment to school. In fact, they spend part of their study hall time working with their equipment and usually attract a crowd of classmates. Before you know it about thirty boys are working with the equipment."

"As the seniors arrived, I presented them to their groups and tried to explain briefly that we would be having fun with science. I told them that this work would be completely ungraded and no homework or tests would be included. They were, of course, thrilled by this announcement and from this time until the conclusion of our work, this excitement never really left. The girls were eager to learn, curious about their kits, and fascinated by the 'Big Girls' who were there to 'teach' them."

"Although the groups are large, the fourth graders seem to love every minute of the time they are spending here and the session seems to fly by in spite of apparent disorganization. Group size and the lack of self-confidence of the instructors were concerning me at this time. The 'teachers' seemed to lack enthusiasm."

"I felt that this particular unit (Gases and Airs) was not completely adaptable to our curriculum as it stands, but I am very much in favor of this type of learning for children in the elementary grades. They love the informality of the sessions and I found that the same children who in a disciplined class were normally more withdrawn and poorer students really shown in this type of situation. Children too soon lose their enthusiasm and interest in things of science and this medicine is the sure cure for that dread illness."

"The system of rotating PSSC student teachers seems to be working satisfactorily. They tire less quickly, retain their enthusiasm, and endorse the program to their classmates. I

have been especially pleased with the initiative shown by some of the students waiting their turn. One rather weak student thought of some rather interesting circuits to show his students."

"The feeling hit me that actual concept learning had been accomplished by <u>all</u>, whether 11 or 17, as well as a good deal of lab technique and know-how. They learned to look for large numbers of results before coming to a conclusion. They began to delve and didn't hesitate to inquire. The younger girls started acting on their own and the older ones <u>let</u> them."

"Because of the natural enthusiasm and vitality of the high school students, this material was alive and fascinating to the elementary students."

"I would recommend this project to be done much more often in other situations. It is not only an excellent way for children to be taught, but it is an excellent way to stimulate interest in further experimenting on the subject area that is being taught."

"The program was a huge success. You could see it in the eyes of the children. They had their own special teacher who was like an older brother."

"It was amazing for me to see how much the third graders had already learned. Before this work they had rarely worked in a lab situation. After two weeks they were bored with a teacher doing all the work. 'Let us do it.' 'I want to take the battery apart.' This could be heard all over the room. The teachers themselves did not enjoy listening to themselves talk! This must say something for all the teachers who teach by lecturing. How many more children could we reach this way?"

"The teachers seemed to gain much insight into how the little children work. They were disturbed or surprised by the brighter students who seemed to know everything and decided to give these children more to do by adding some enrichment activities to their daily work. They would get disturbed by the slower ones. It bothered them very much that some children did not seem to be learning. The teachers felt that this was a reflection on their own teaching. The sixth graders would then

work harder with these youngsters."

"The greatest benefit of the project was derived by the participating high school physics students. Even though the teenagers knew little about teaching and made mistakes, they became conscious of the problems in a teaching-learning situation from a new viewpoint. It was an experience they will never forget."

"The children, all eager to learn by experimentation, were sincere in the liking of the course. Many took the equipment home so that they could experiment with it; others brought motors, batteries of different sizes, and relay switches, and asked why they worked. The typical answer was, 'See for yourself.' One student brought in a 12 volt car battery, and used it to further his exploration in electricity. In another, an inquisitive girl asked the embarassing question, 'What is electrolysis?'"

IV. Discussion, Conclusions, Implications, and Recommendations

The results do not show clear cut answers to the questions stated in Part III, but there is some evidence that teaching can become a learning situation for students who are given the opportunity to teach. Further study is needed not only in the area of science but in other subject matters and with the same student 'teachers' for a period of several years. If you are interested, try it; you will find that it is a learning situation for you, too.

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7. From a letter to Ervin H. Hoffart by Mrs. Jean Brattin, Shaker Heights Senior High School, Shaker Heights, Ohio. January 4, 1966.

Follow-up Evaluation

Name_____School_____

School Address_____Zip Code_____

1. Did you discuss the new science curriculum materials with:

_____ Science coordinator

_____ Elementary school teachers

_____ Junior high school science teachers

_____ Others (please list)

2. Did your discussions in #1 (above) result in:

_____ science workshops for teachers

_____ trying the new science curriculum materials by teachers in the school system where you are employed.

_____ other (please explain)

3. Do you think a discussion of new science curricula is a valuable addition to the area meeting program?

_____ yes _____ no

Explain:

4. Please use this space for additional comments.

OE-BR
must
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